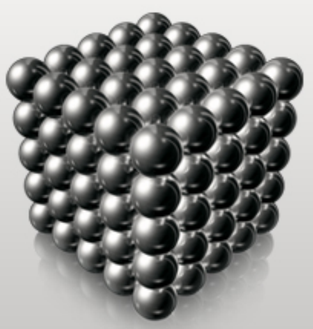
HPC Technology Update

Session 609

These are confidential sessions—please refrain from filming or taking pictures.



Enterprise IT

HPC Technology Update

Skip Levens
Server Technology Manager

http://developer.apple.com/wwdc2005/

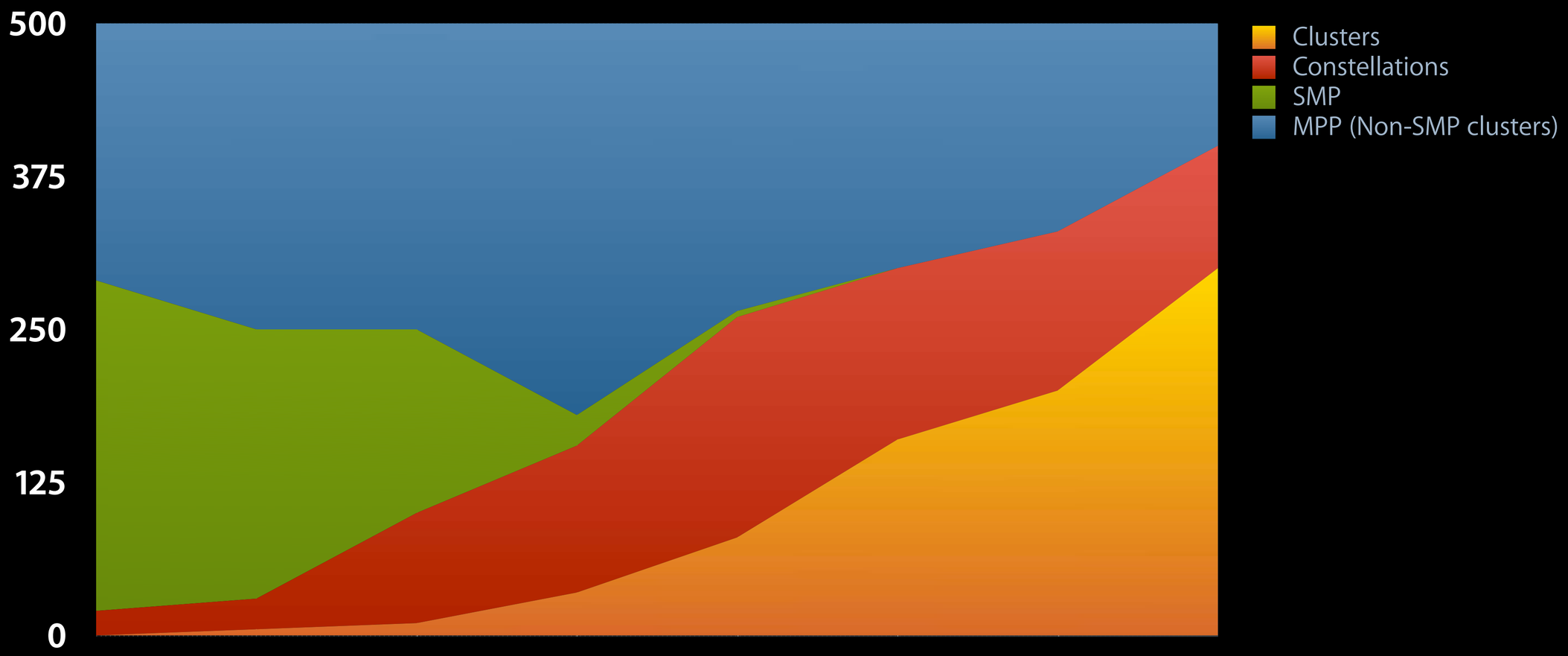
What We'll Cover

- HPC trends and Apple deployments
- HPC technology survey, including:
  - Interconnects—Myrinet, SilverStorm
  - Tools—Absoft Update
- Technology demo
- Wrapup

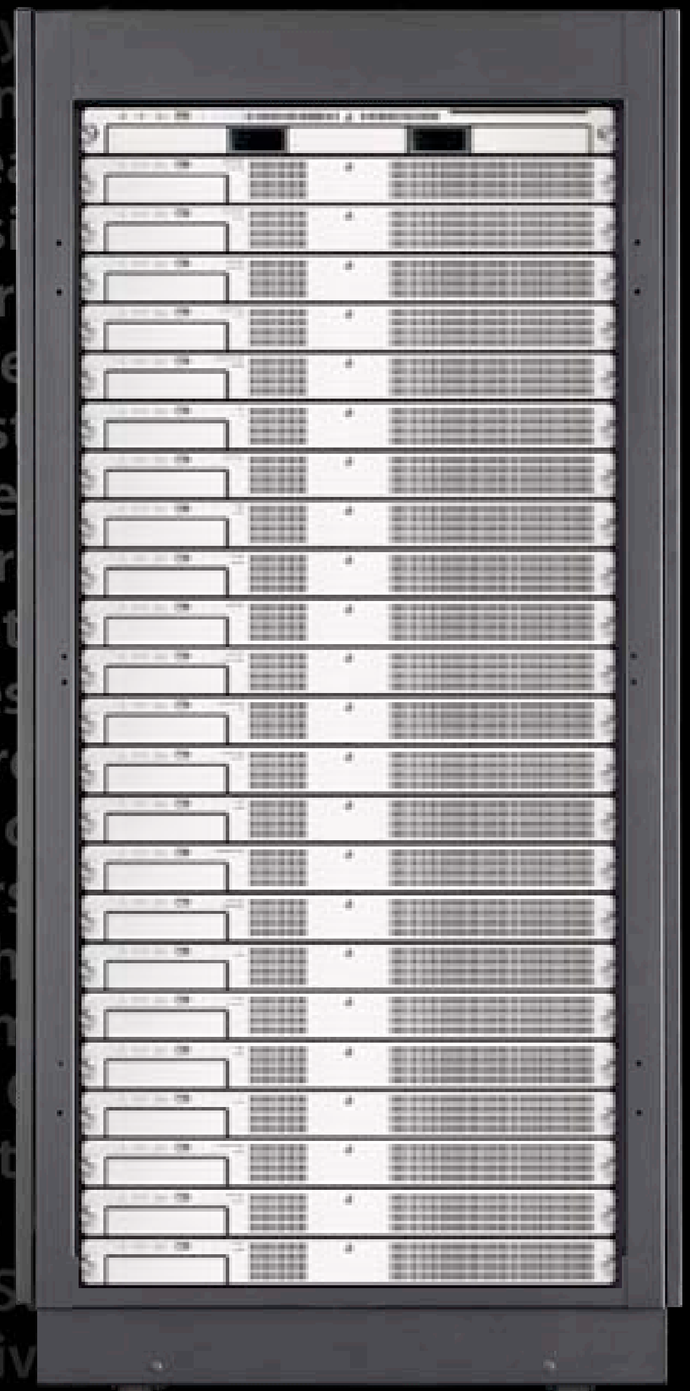
HPC Trends and Apple Deployments

http://developer.apple.com/wwdc2005/

Supercomputer Architectures Since 1998



Virginia Tech University • University of Illinois • University of California Los Angeles • Yale University • Princeton University • University • Danforth Plant Institute • Sandia National Labs • Mayo Clin California Davis • Texas A&M University • Naval Medical Resea • Pacific Title • University of Michigan • Georgetown Universi Virginia • University of California San Diego • Dana Farber • Purdue University • Beth Israel Medical Center • McGill Unive of North Carolina • Temasek Life Sciences Laboratory • Aust Defence • Jet Propulsion Laboratory • Outpost Digital • Unive University of Colorado • University of Albany • Mitre Corpor Livermore National Labs • Beth Israel Deaconess Medical Cent Pittsburgh • Academia Sinica • Monterey Bay Aquarium Res Purdue University • United States Department of Agricultur Reserve University • Harvard University • National Institute o Health Sciences • Idaho State University • Stanford Univers University • Children's Research Institute • University of Mich of Idaho • Queens College • Hunter College • Bingham University of Oregon • Rockefeller University • Hamilton C University • University of North Carolina Charlotte • Universit Madison • Furman University • University of Kentucky • University of Toronto • University of Iowa • Washington S University of Florida • University of Michigan Dearborn • Univ Washington State University • University of Southern California • Colorado University • University of Maine • University of Chicago • COLSA Corporation •



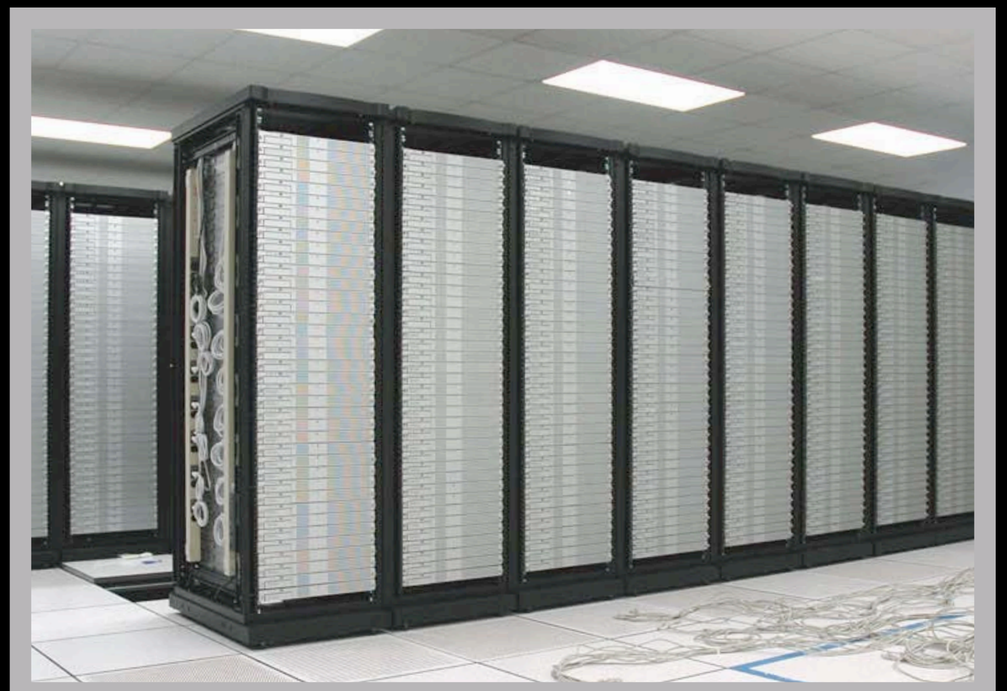
Virginia Tech—'System X'

- Converted from Dual 2.0 GHz PowerMac workstations to 2.3 GHz Xserve G5's
- Footprint reduced by 2/3
- 425KW load reduced to 310KW
- Generated 12.25 Teraflop Run to qualify at #7 on Top500, remains #1 Academic Cluster
- Entered production and helping drive new applications to Mac OS X

UCLA—Dawson Cluster

- 256 Xserve G5 nodes (128 2.0 GHz and 128 2.3 GHz)
- GigE and LAM/MPI
- Entered production quickly
- Generated .948 Teraflop run to qualify as #444 on Top500 list
- Have since generated a 1.21 TF run using Dauger Research PoochPro and MacMPI

COLSA—MACH 5



- 1562 Dual 2.3 GHz Xserve G5 Cluster Nodes
- Gigabit Ethernet
- Hypersonic Missile Research
- Highly dense CFD codes

UIUC—Turing Cluster

- Used by Computational Science and Engineering and Center for Simulation of Advanced Rockets
- 640 nodes (plus 10 utility servers)
- Myrinet interconnect
- $3M for 10 Teraflop peak (includes nodes, network and data center cooling and power upgrades)

Bowie State—XSEED

- 224 Dual 2.0 Xserve G5 Nodes
- Myrinet Interconnect
- 2.104 Teraflop benchmark run
- Student and faculty planned and deployed

Apple Workgroup Cluster

- Turnkey Cluster Computing
- Within reach of workgroup, department or discretionary budget
- Scale to fit your needs

HPC Technology Survey

http://developer.apple.com/wwdc2005/

Applications

Tools

Resource Management

File Systems

Code Libraries

IPC Middleware

Hardware Interconnects

OS Platform

Hardware Platform

Applications

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Hardware Platform

Hardware Platform

Xserve G5 and Xserve G5 Cluster Node

- Basic building block
- 64-Bit computing and memory
- Capable of up to 35 Billion single-precision or 10 Billion floating point instructions per second
- Well-balanced design of I/O throughput, environmentals and processing power
- Now supports 2GB DIMMS for up to 16GB of ECC memory

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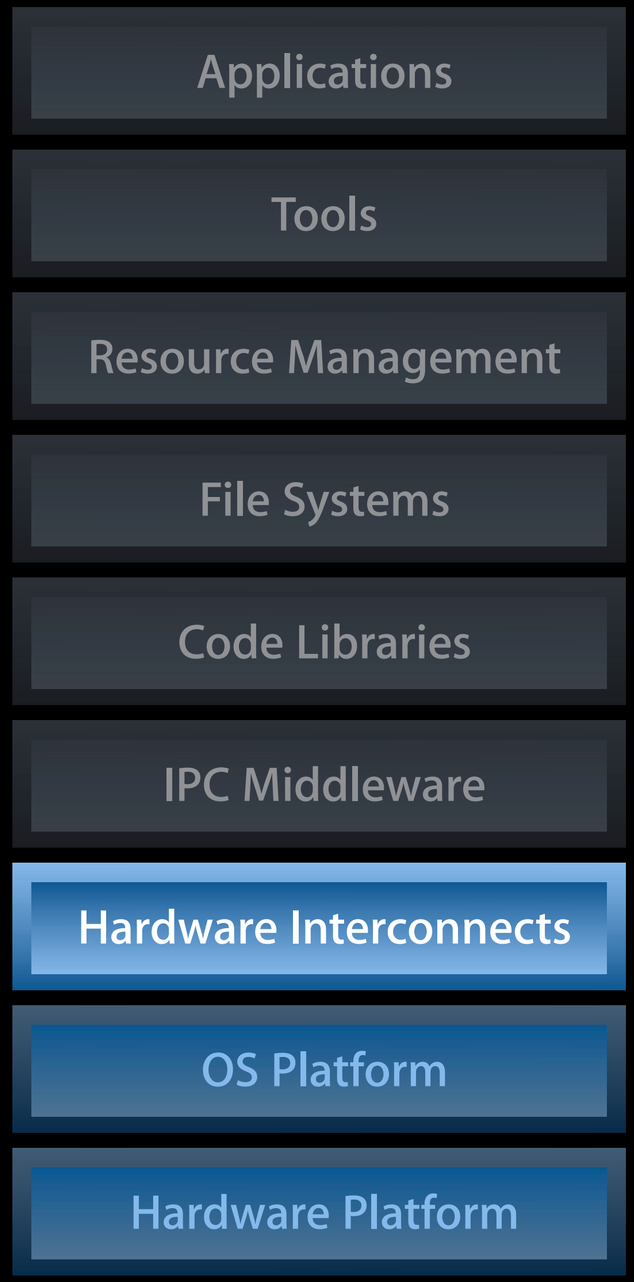
Tiger Server

HPC Benefits

- 64-bit memory address space
- Xcode 2
  - gcc 4.0
- Kernel tuning via launchd now
- Memory Manager Code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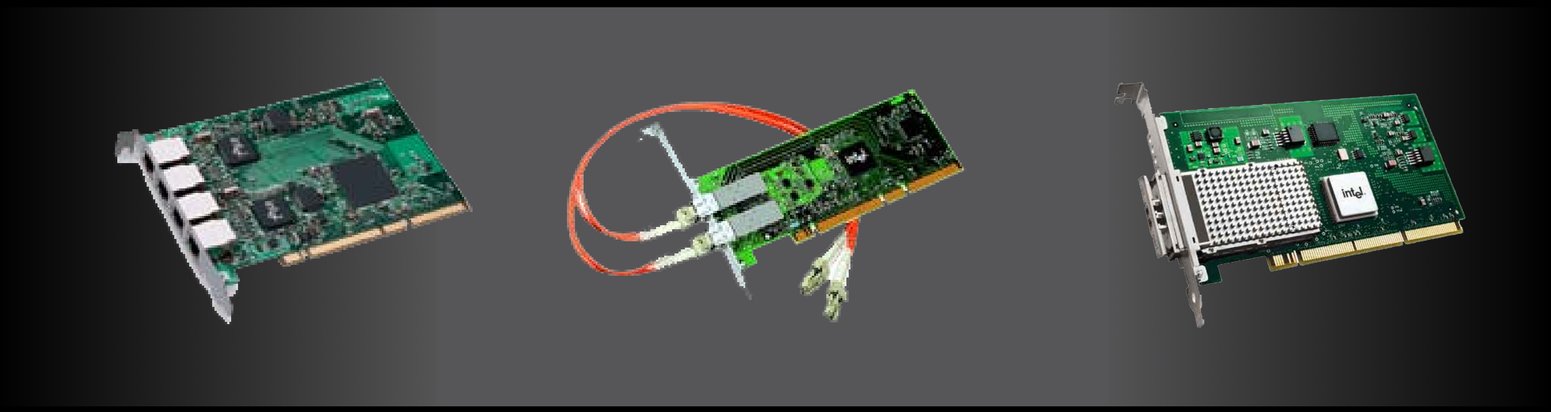
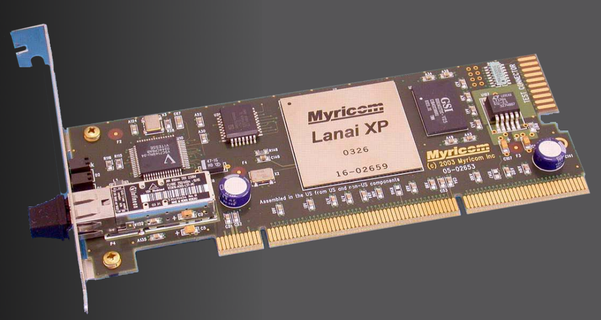
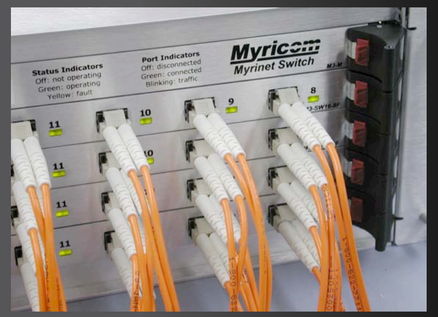
Hardware Interconnects—Gigabit Ethernet

- GigE
- Multiport GigE Expansion Cards, optical GigE, 10GigE



Hardware Interconnects—Myrinet





Myrinet

What's new?

- Two new Xserve clusters with Myrinet will appear in the June 2005 TOP500 Supercomputer list
- Myrinet Express (MX)
  - A new message-passing system for Myrinet clusters
  - MX-2G is released for Myrinet PCI-X NICs
  - Much lower latency than GM
    - 3.6µs raw MX, 3.8µs MPICH-MX, measured on G5s with E or F cards
  - Great ethernet-emulation performance
  - Complete set of middleware
    - MPICH2-MX coming soon

Myrinet Express (MX) and Mac OS X

- MX uses a new approach to memory management
  - Small and medium messages (<32KB) are copied
  - Large messages are pinned/unpinned on demand
  - Tiger's improved U3 DART code makes this practical on Mac OS X
  - 4x as much memory is available for communication vs GM
    - 375MB with GM vs 1.5GB on MX
  - Linking complex MPI applications is as easy with MPICH-MX as it is with a sockets-based MPI because there is no need to override malloc/free
- Tested with Apple's gcc-4
- Experimental support for 64-bit binaries on Tiger
- The ethernet-emulation interface with Tiger can be configured via System Preferences, just like any other ethernet interface

Hardware Interconnects—InfiniBand

- SilverStorm Technologies and Small Tree Communications

SilverStorm Backgrounder

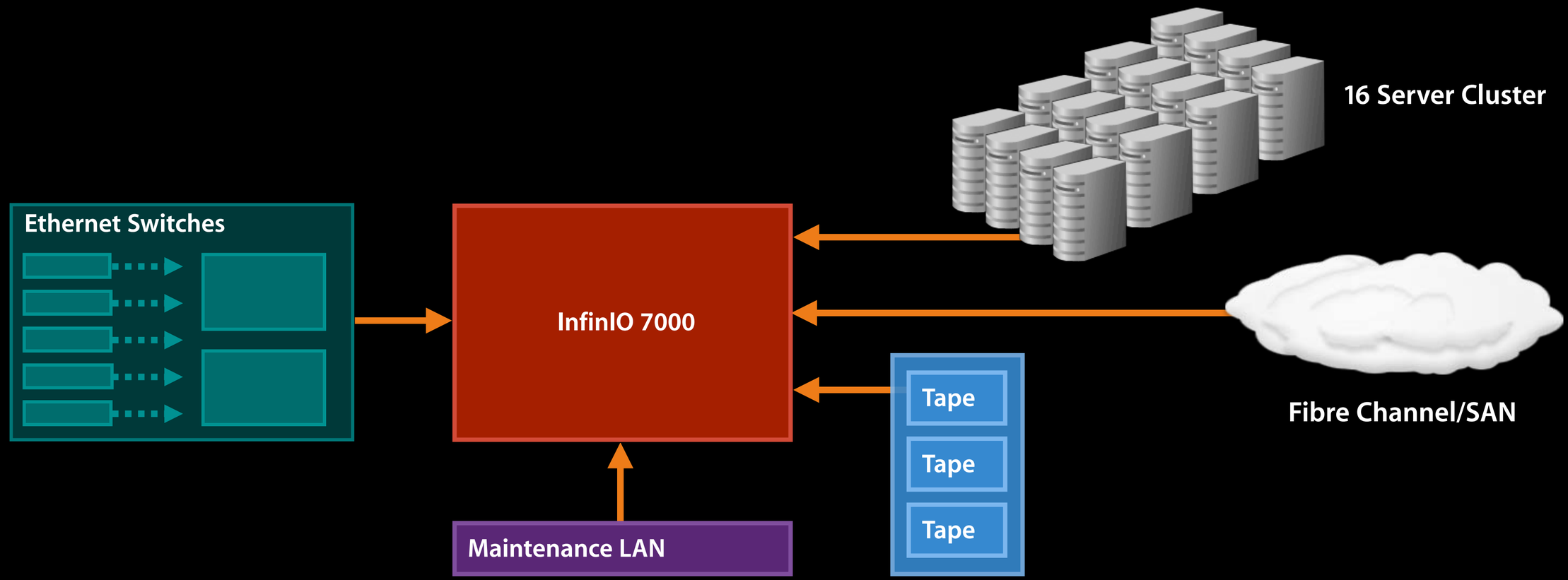
- Founded in June 2000 (formerly InfiniCon Systems)
- Sales and support teams across the US, Europe, and Asia
- Proven management and development experience in delivering enterprise-class networking and server I/O products
- Complete end-to-end solutions for HPC and enterprise computing
  - Shared I/O Systems—InfiniBand, Fibre Channel, Ethernet
- Partnered with Apple and Small Tree Communications to deliver a complete software solution for Mac OS X
- Well funded with over $50M raised

Small Tree Backgrounder

- Hardware and Software development experience from Cray, SGI, Sun, and HP
- Technology Partnerships include Intel, Silicom, Apple, and SilverStorm
- System Integration expertise for HPC
- Wide range of offerings including GigE, multiport GigE, 10GigE, and InfiniBand
- Focused exclusively on Mac OS X platform

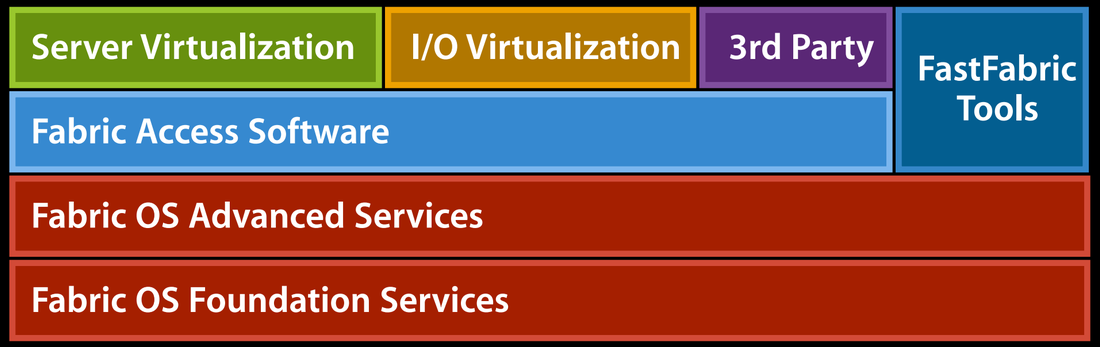
Vision for High Performance Computing

- ‘One Wire’ Data Center Computing
- High Performance Commercial Computing
- High Performance Technical Computing



SilverStorm Technologies Product Family

End-to-end networking solutions



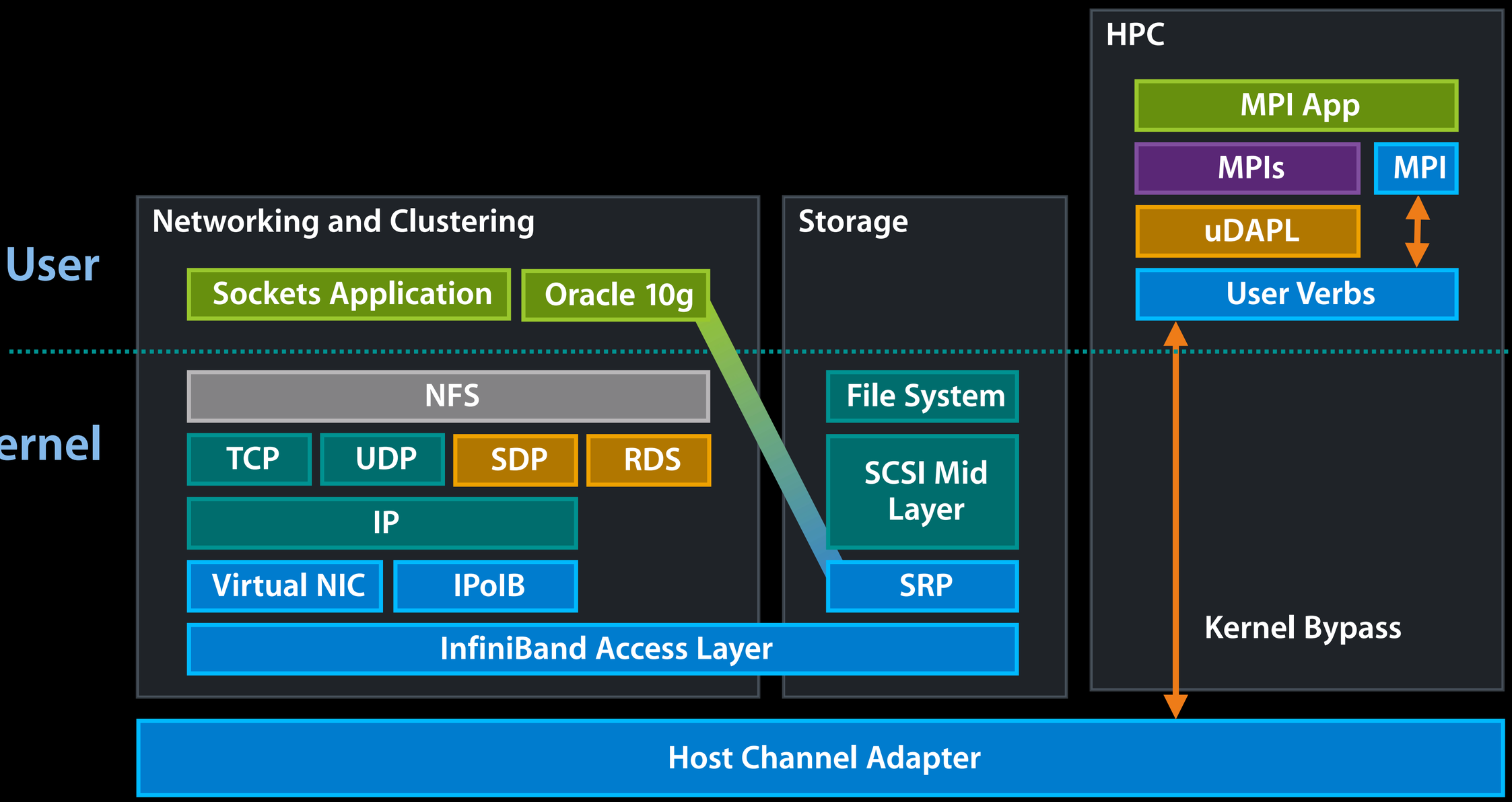
QuickSilver SW Architecture

Flexible Switch Configurations

InfiniBand HCAs

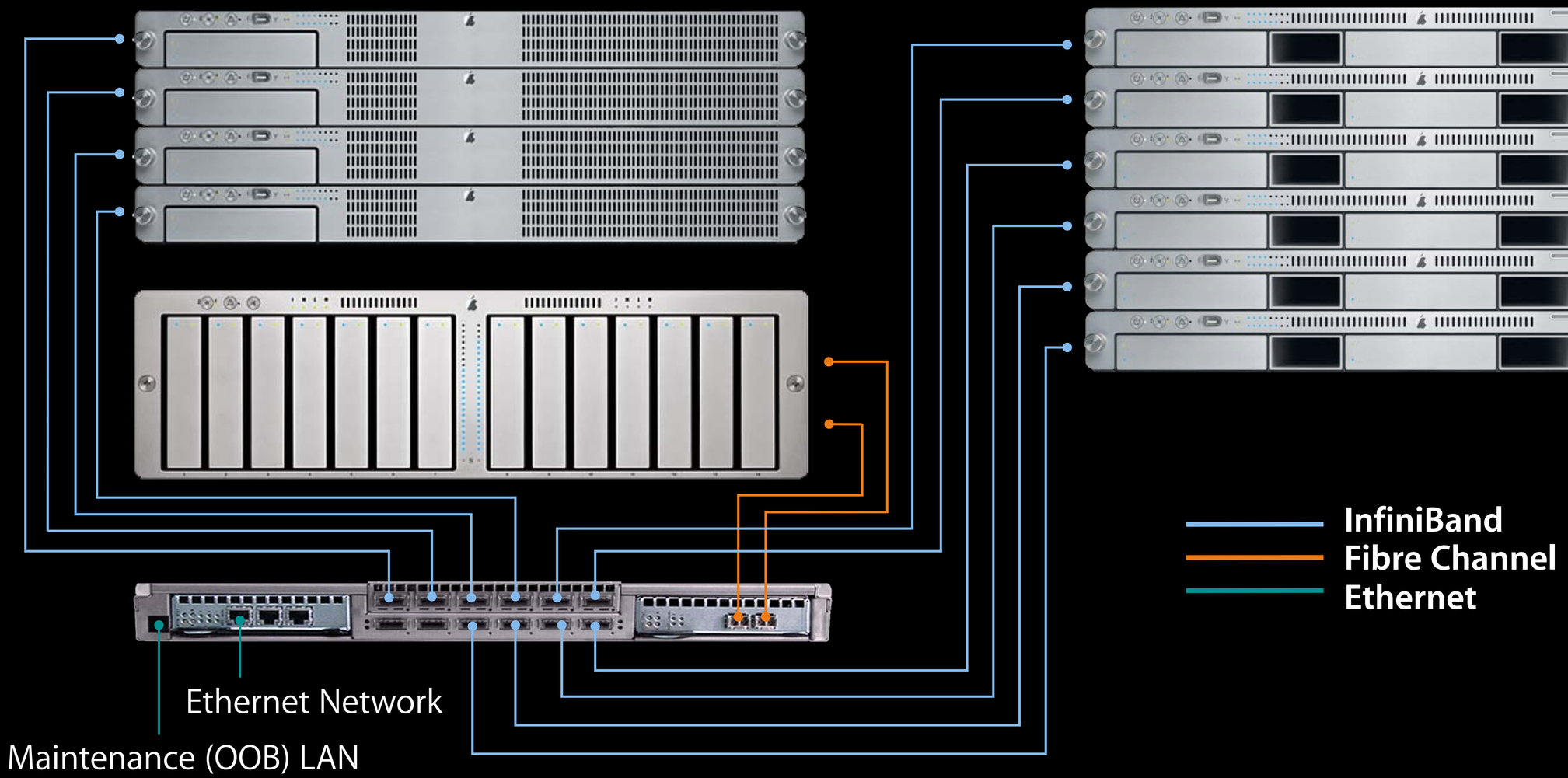
Virtual I/O

Highly Scalable Host Software Infrastructure



High Performance Network Consolidation

InfiniBand as single server connection for IPC, storage and networking



Strategic Software and Technology Partnerships

MPI

- OHIO STATE
- Verari systems
- SCALI High Performance Clustering
- intel

Manufacturing

- LSTC Livermore Software Technology Corp.
- CD adapco Group
- ABAQUS
- ESI GROUP THE VIRTUAL TRY-OUT SPACE® COMPANY
- FLUENT
- ANSYS

Oil & Gas

- WesternGeco
- Landmark A Halliburton Company
- VERITAS
- Schlumberger

Life Sciences

- BLAST
- Gaussian.com THE OFFICIAL GAUSSIAN 03 WEB SITE

Data Base

- ORACLE

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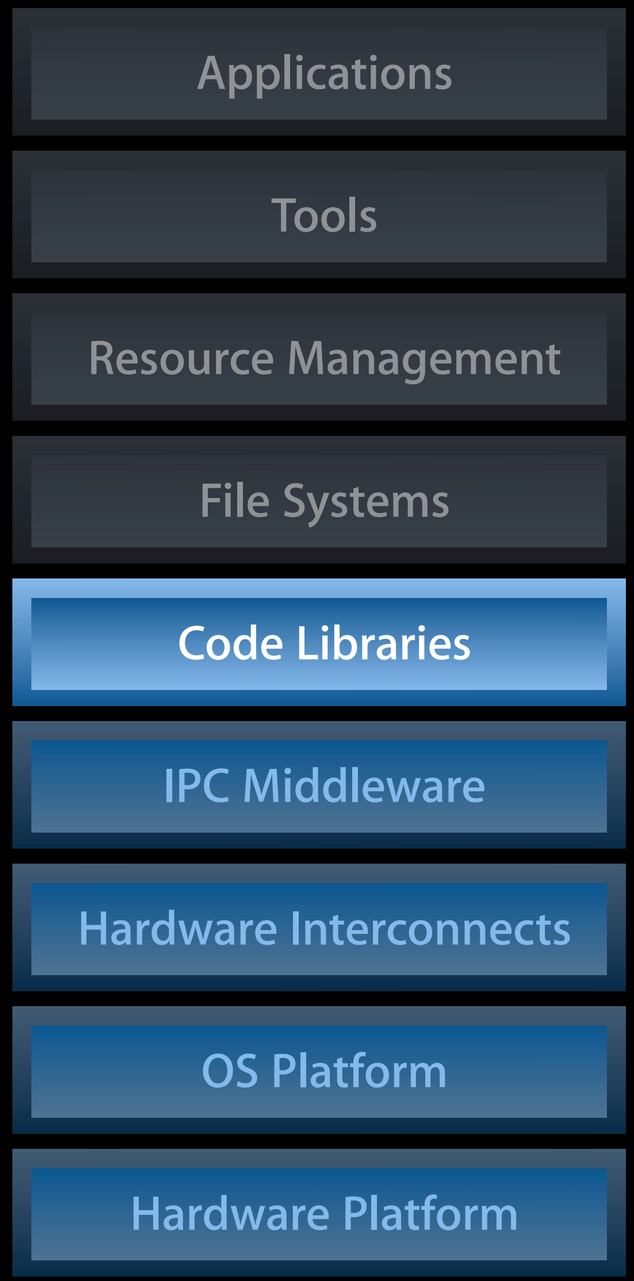
IPC Middleware

- LAM/MPI
- Open MPI
- MPICH from Argonne National Labs
- MVAPICH from Ohio State
- MPI/PRO from MPI Software Technology
- MacMPI_X and LnxMPI_S from UCLA
- Globus
- Linda/Paradise from Scientific Computing Associates
- Massively Parallel
- SilverStorm/Small Tree MPI
- PVM from Oak Ridge National Laboratory
- XLR8 from GridIron Software
- MPICH GM/MPICH MX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Code Libraries

- Accelerate Framework from Apple
  - BLAS Levels 1, 2, 3 (ATLAS tuned, selectively SMP aware)
  - LAPACK, linear systems and eigenvalue problems
  - Digital Signal Processing, 1D, 2D FFT's [vDSP]
- Absoft IMSL Math Libraries
- NAG Math Libraries
- Goto BLAS
- Verari
- CCSM
- CTH

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File Systems

- NFS
- AFP
- Xsan
- Lustre
- Blaze

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Resource Management

- Schedulers
  - Xgrid
  - Platform LSF
  - PBS Pro from Altair Engineering
  - N1 Grid Engine from Sun
  - Maui/MOAB
  - Torque
  - Pooch
- Management and Monitoring
  - Ganglia
  - Big Brother from Quest Software
  - Oscar HA

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Tools

Compilers/Debuggers/Profilers, Optimizers

- Xcode
  - gcc/gdb 4.0
- Absoft xlc/xlf
- Absoft Pro Fortran
- Absoft FxP
- Etnus TotalView

Absoft HPC Tools

Rodney Mach
Absoft HPC Technical Director
rwm@absoft.com

http://developer.apple.com/wwdc2005/

About Absoft

- Continuous tools support for Apple platforms since 1984
- First commercial Fortran and Fortran 95 compilers available on the Apple platform
- Continuing development of cutting edge developer and high performance tools for OS X Tiger

Absoft Solutions

- HPC SDK Basic Edition for Xserve clusters
- FxP MPI Debugger for OS X Tiger/Panther
- 64-bit and 32-bit Pro Fortran compiler for Tiger
- 64-bit and 32-bit IMSL Fortran Numerical Library v5.0 with serial and parallel support

HPC SDK for Xserve Clusters

- Includes high performance commercial compilers, debuggers, math libraries, MPI and other developer tools optimized for Xserve clusters
- Start developing HPC applications within seconds of installation
- Increase productivity with the seamless integrated HPC development environment

Best of Breed Components

- 64-bit and 32-bit Absoft Pro Fortran
- 64-bit and 32-bit IMSL Fortran Numerical Library v5.0 with serial and parallel support
- Absoft FxP MPI Debugging Solution
- MPICH2 and LAM/MPI
- VAST (Altivec and Automatic Parallelization)

FxP MPI Debugger Benefits

- Supports all major compiler vendors and MPI implementations in one package
- Easy to use graphical user interface is simple to learn and highly intuitive for immediate productivity and reduced training costs
- Builds on market leading Fx2 serial debugger for Fortran, C/C++, and assembler

FxP Features

- Basic MPI debugging support
- Automatically attach to MPI processes
- Connect to remote batch jobs for debugging production jobs
- View local and global variables, stack trace, registers, message queues, across all MPI processes
- Visually see the state of all running processes

Absoft Pro Fortran 9.2

- Supports 64-bit and 32-bit Fortran 95
- Free technical support
- Includes C/C++ compilers, IDE, Fx2 graphical debugger at no extra charge
- Fully link compatible with GNU compiler
- Includes BLAS, LAPACK90, ATLAS, HDF, Vax/Unix, and 2D/3D libraries

IMSL Fortran Numerical Library v5.0

- Complete collection of well documented mathematical and statistical algorithms for HPC, including 64-bit and 32-bit libraries; parallel and serial support
- MPI Parallel Processing support allows you to take advantage of your Xserve cluster
- MPI Complexity hidden from the user

Roadmap

- Continue to improve speed of our compilers, tools, and utilities
- Full Fortran 2003 support
- Introduction of new HPC tools
- Continued emphasis on our outstanding technical support
- Support for Intel-based Macs

Questions?

- For telephone inquiries, call: Jeff Livesay (248) 853-0050

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Massively Parallel Technologies

Kevin Howard
President, CTO
Massively Parallel

http://developer.apple.com/wwdc2005/

Why Massively Parallel Technologies?

Massively Parallel Technologies (MPT) was founded to tackle the limiting factors in today's supercomputers

- MPT is based upon a new derivative of Amdahl's law that allows for superlinear performance
- MPT's proprietary communication models take full advantage of these new capabilities
- MPT is currently demonstrating linear and superlinear performance on Mac OS X Tiger

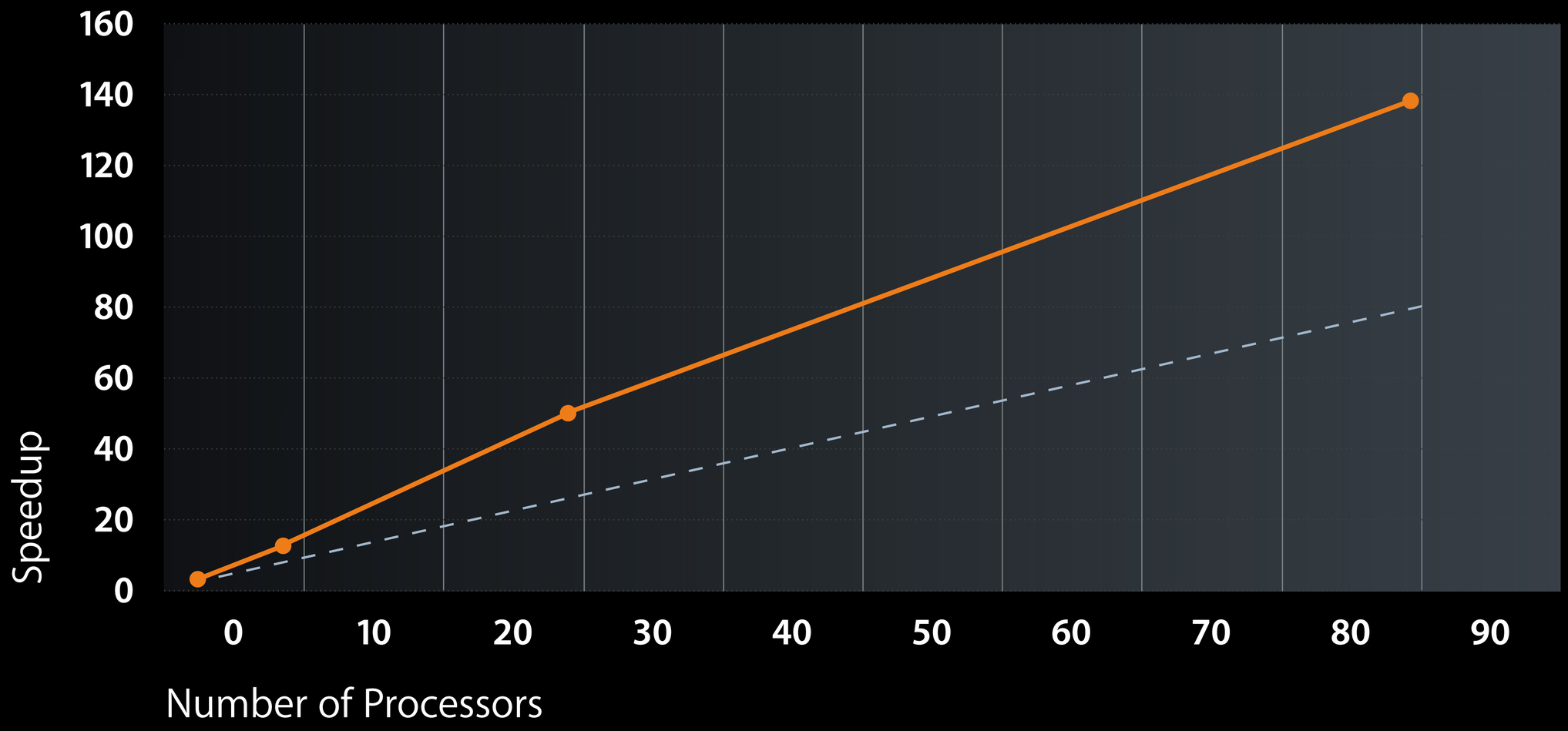
MPT HOWARD® Software Technology

Developer opportunities

- No need to rewrite applications—simply replace compute-intense functions with HOWARD® library functions
- Deliver higher parallelization performance using HOWARD® library functions
- Faster time to solution—HOWARD® library functions easy and intuitive to use

HOWARD® Speedup

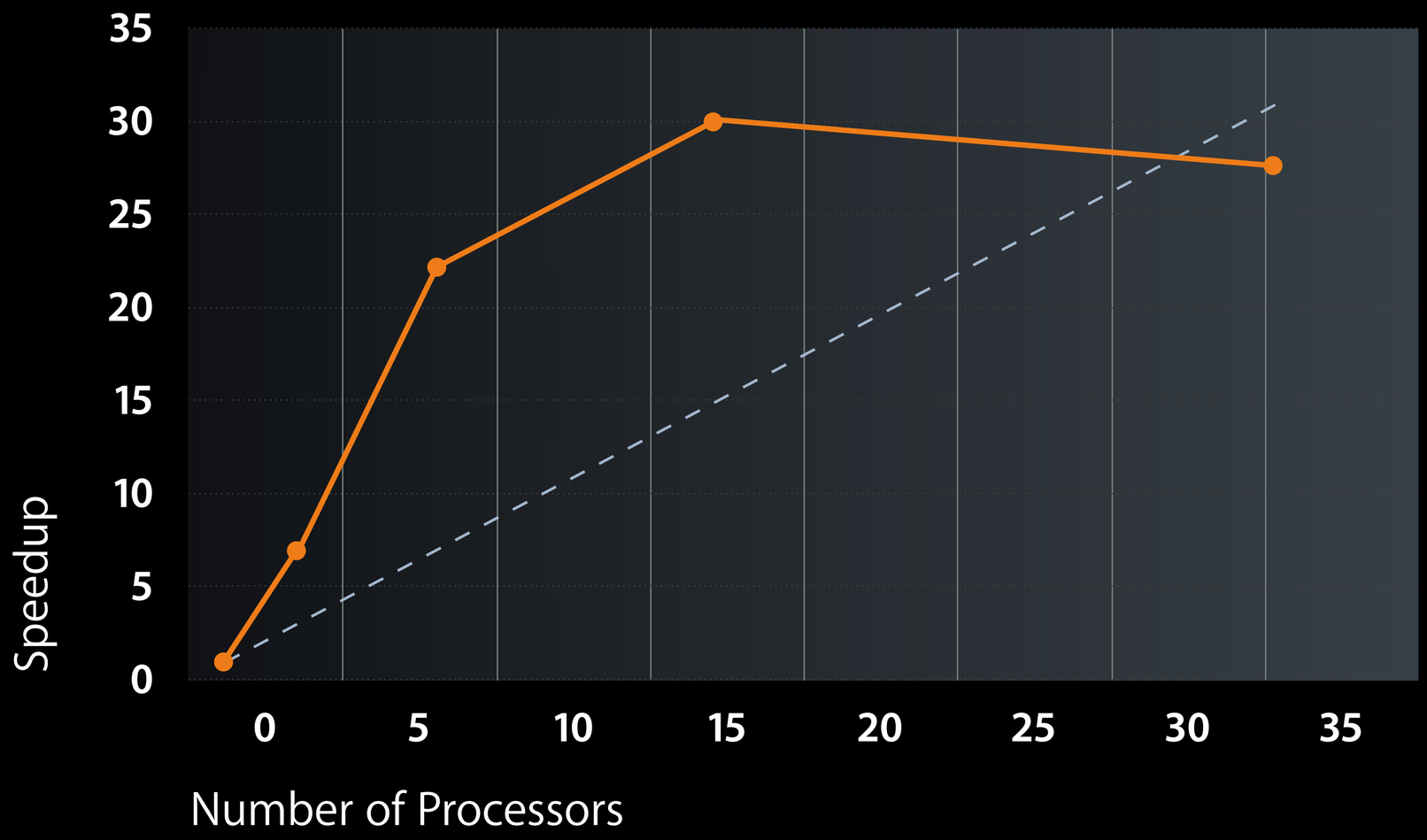
ex, 20,000 Digits of Accuracy, Two-Channels



U.S. Patent #6,857,004 Other Patents Pending

HOWARD® Speedup

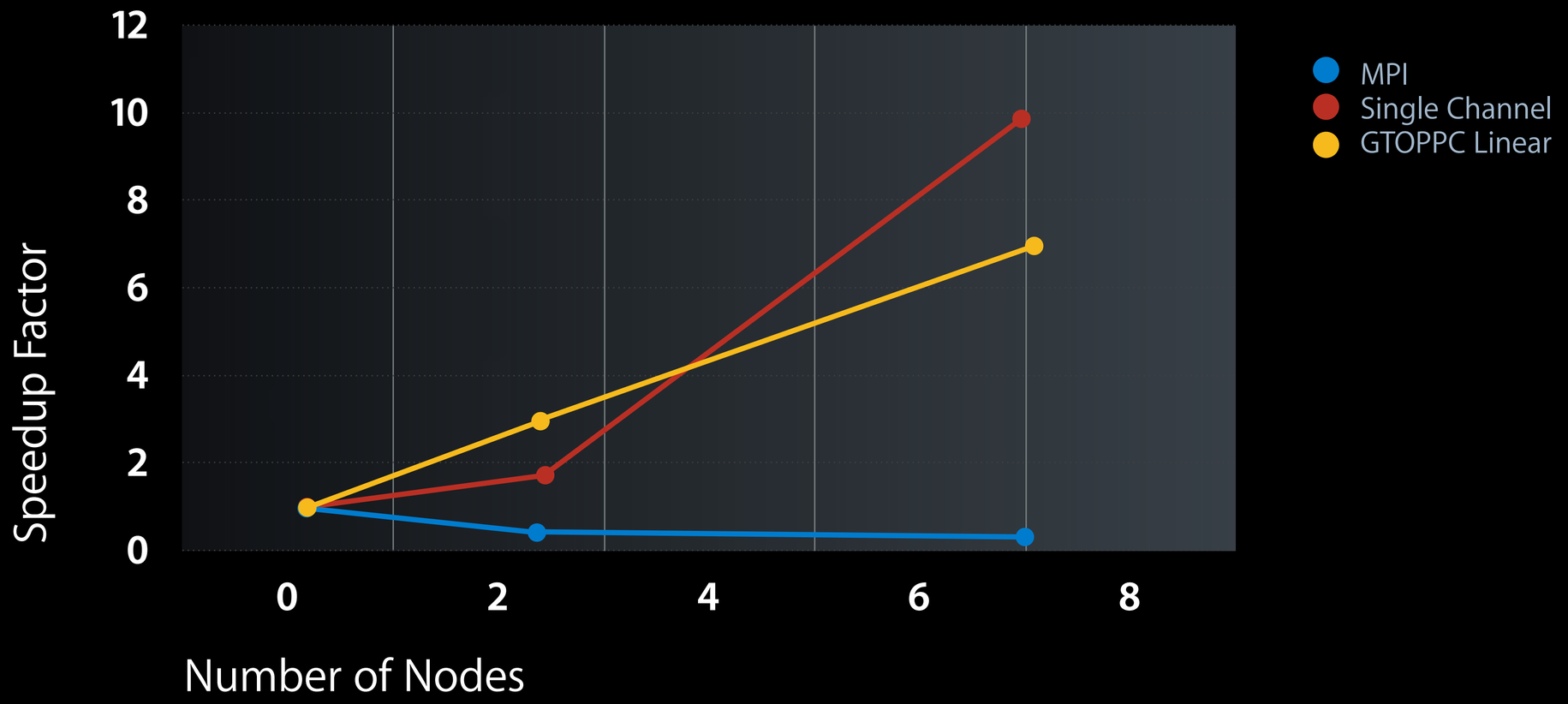
Triangulated Irregular Networks



U.S. Patent #6,857,004 Other Patents Pending

HOWARD® Speedup

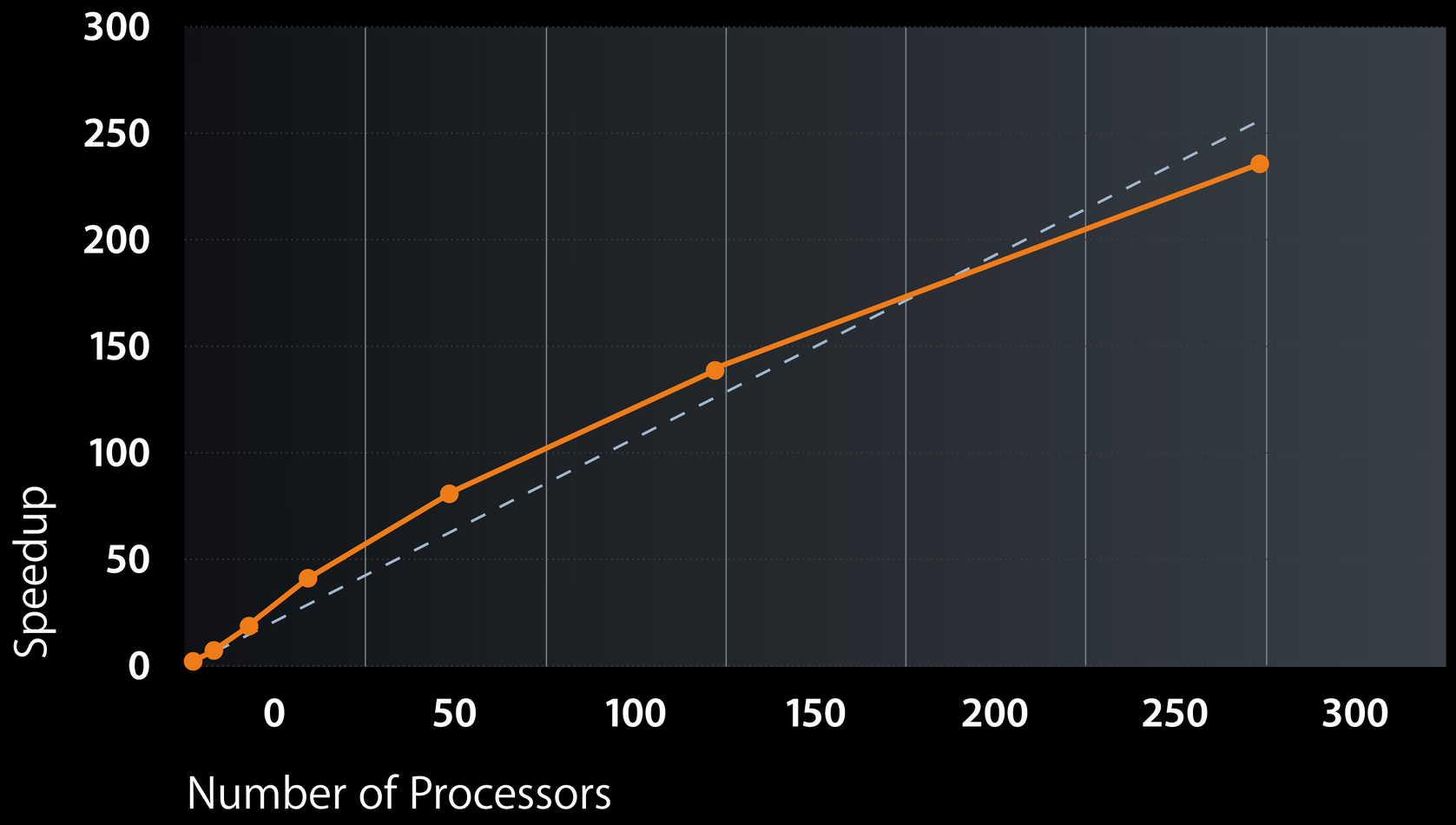
LU Decomposition, Speedup Comparison (Daisy)



U.S. Patent #6,857,004 Other Patents Pending

HOWARD® Speedup

NCBI-based blastp



U.S. Patent #6,857,004 Other Patents Pending

The Technology Breakthrough

Effective Bandwidth

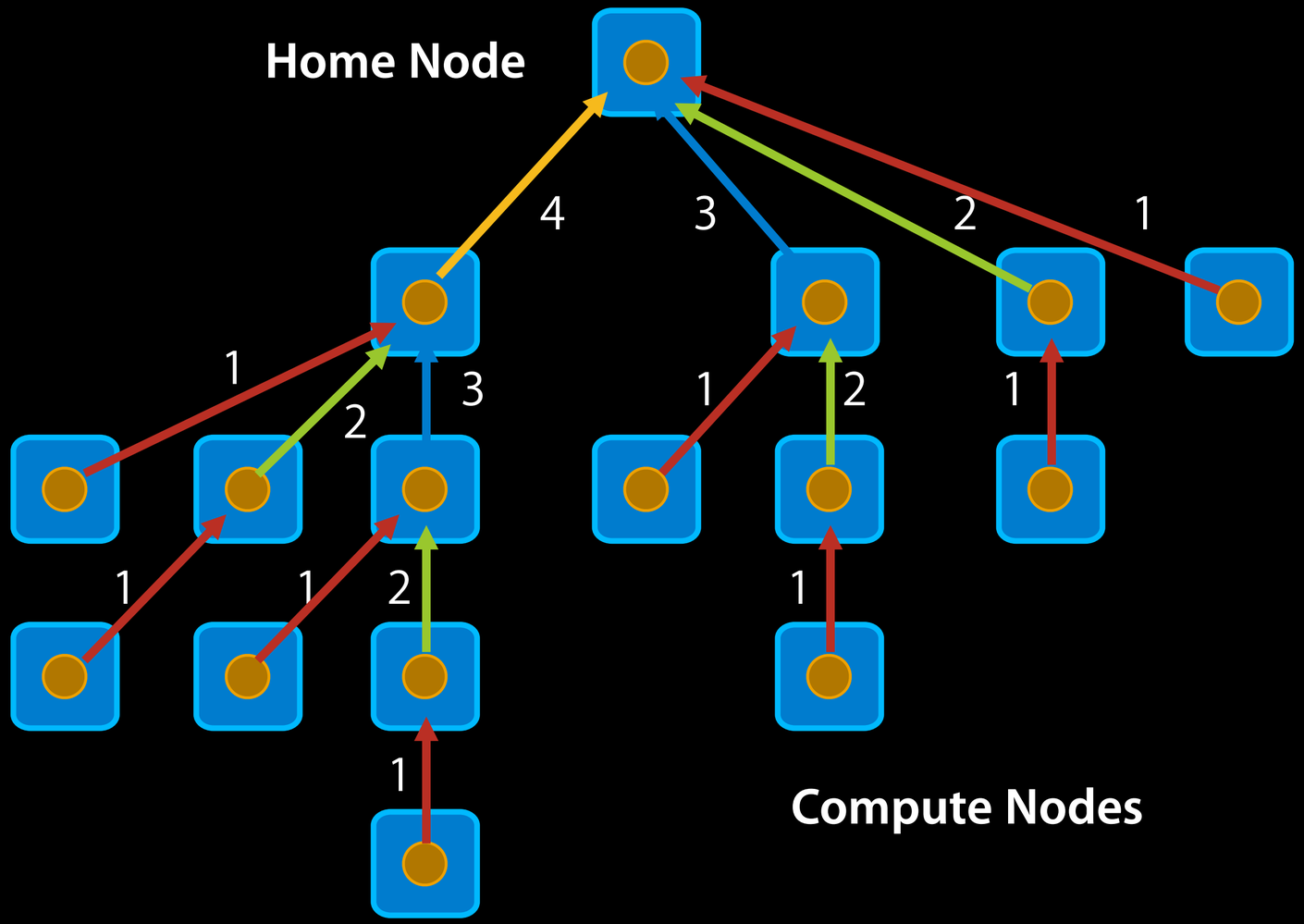
100 BaseT Point-to-Point Bandwidth

	Time Unit	Cascade A Effective Bandwidth	Cascade B Effective Bandwidth	Cascade C Effective Bandwidth	Manifold A Effective Bandwidth
1	100 Mb/s	200 Mb/s	200 Mb/s		
2	300 Mb/s	600 Mb/s	800 Mb/s	600 Mb/s	2.0 Gb/s
3	700 Mb/s	1.4 G/bs	2.6 G/bs	1.8 G/bs	8.0 G/bs
4	1.5 Gb/s	3.0 G/bs	8.0 G/bs	4.2 G/bs	26.0 G/bs
5	3.1 Gb/s	6.2 G/bs	24.2 G/bs	9.0 G/bs	80.0 G/bs
6	6.3 Gb/s	12.6 G/bs	72.8 G/bs	18.6 G/bs	242.0 G/bs
7	12.7 Gb/s	25.4 G/bs	218.6 G/bs	37.8 G/bs	2.2 G/bs
8	25.5 Gb/s	51.0 G/bs	656.0 G/bs	76.2 G/bs	6.6 G/bs

U.S. Patent #6,857,004 Other Patents Pending

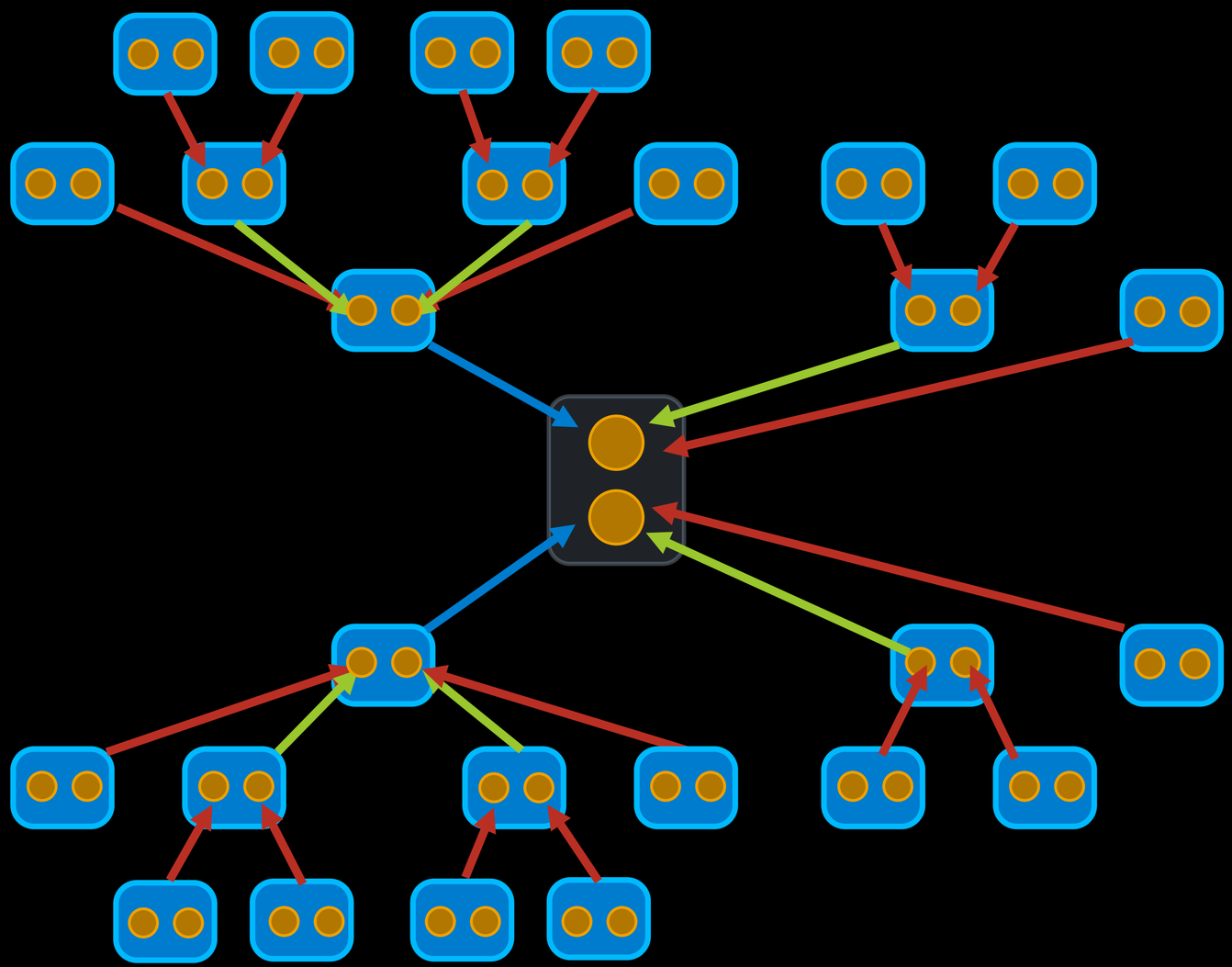
Technology Effects

HOWARD® Cascade, Single-Channel



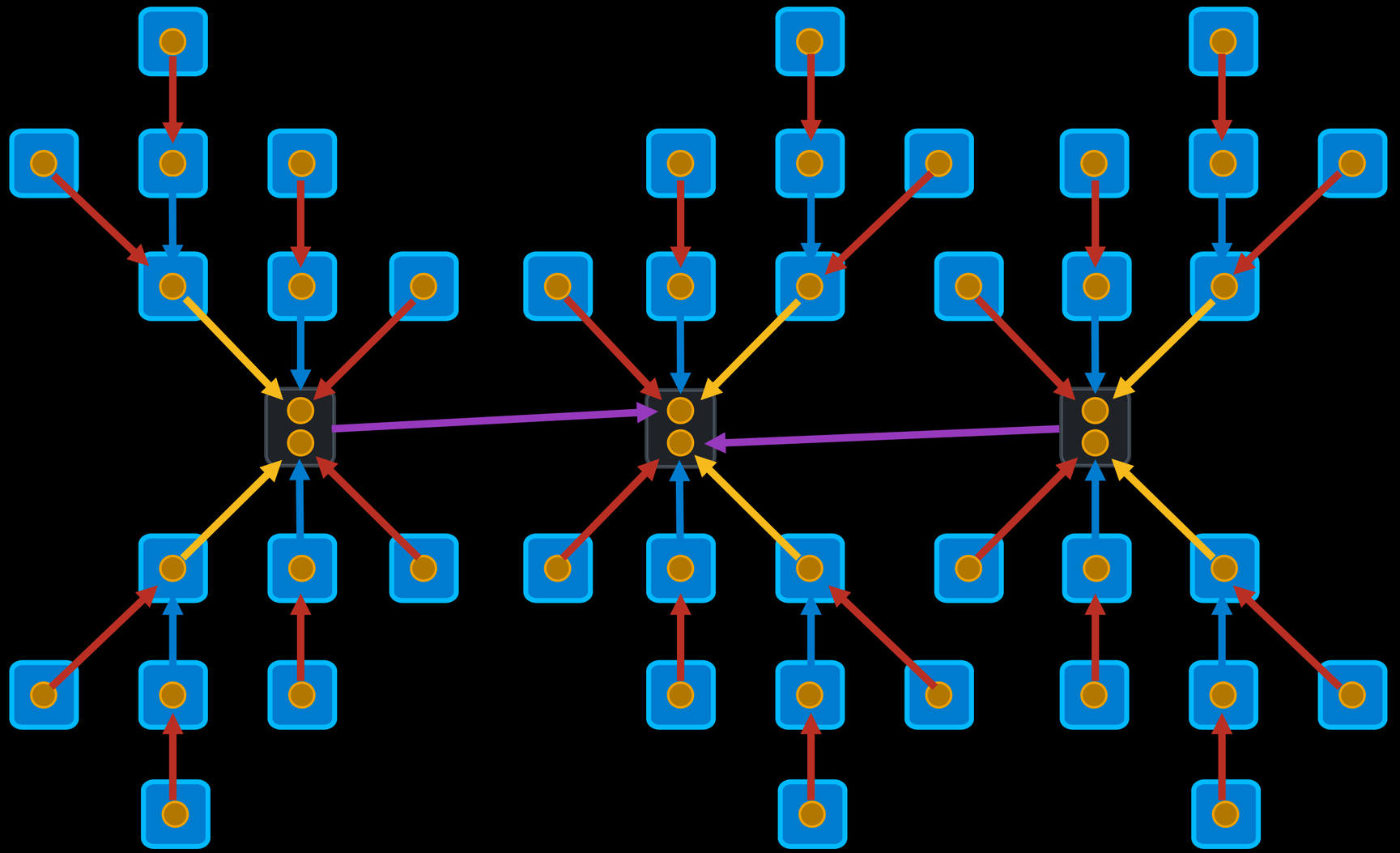
Technology Effects

HOWARD® Cascade, Two-Channel



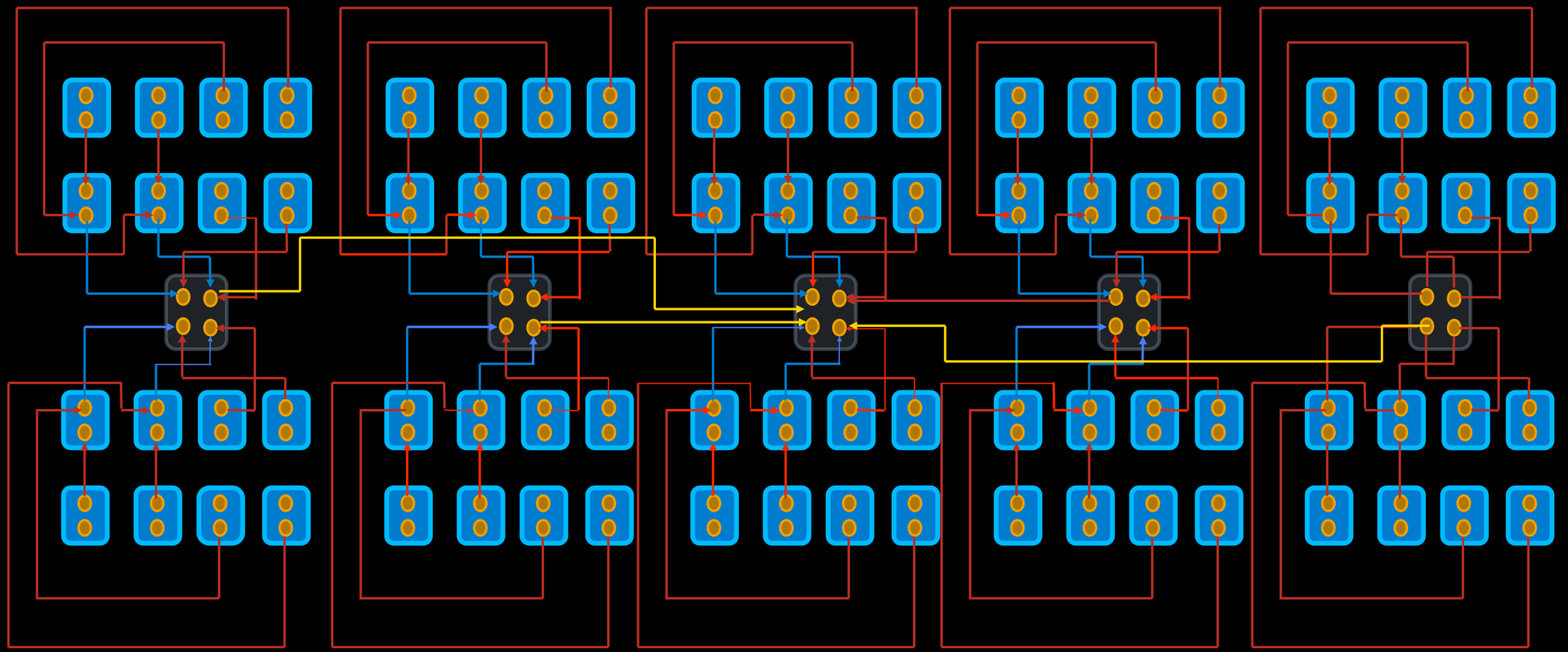
Technology Effects

HOWARD®-Lupo Manifold, Single-Channel, Four Time Units



Technology Effects

HOWARD®-Lupo Manifold, Two-Channel, Three Time Units



Massively Parallel Demo

http://developer.apple.com/wwdc2005/

MPT Applications and Markets

- Bioinformatics
- Molecular modeling
- Image processing
- Neural networks
- Seismic processing
- Computational fluid dynamics

Contact MPT

www.massivelyparallel.com
info@massivelyparallel.com
303-926-8555

More Information

http://developer.apple.com/wwdc2005/

Apple HPC Resources

- Performance and Optimization Workshops
- Apple System Engineers
- Developer Technical Support
- Driving an HPC application to Mac OS X
- Driving a technology to Mac OS X

Resources

Apple SciTech List
lists.apple.com/mailman/listinfo/scitech
scitech@lists.apple.com

Apple HPC List
lists.apple.com/mailman/listinfo/hpc
hpc@lists.apple.com

HPC page at developer.apple.com
http://developer.apple.com/hardware/hpc/

Apple in Science
apple.com/science

Related Sessions

Large Installation and HPC Systems Administration	Session 618 Wednesday 3:30PM
Using HPC: Infiniband Cluster	Lab 6008 Wednesday 5:00PM
Using Xgrid to Create and Deploy Distributed Computations	Session 616 Wednesday 2:00PM
Using Xgrid	Lab 6018 Friday 2:00PM
Debugging Parallel Applications	Session 643 Friday 5:00PM

Who to Contact

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WWDC2005

Worldwide Developers Conference